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# Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Conducted and published for the Club, by

REED CLARK ROLLINS, Editor-in-Chief

ALBERT FREDERICK HILL
STUART KIMBALL HARRIS
RALPH CARLETON BEAN
RICHARD ALDEN HOWARD
CARROLL EMORY WOOD, JR.
} Associate Editors

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The New England Botanical Club, Inc.

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PLATE 1181. Black-drink ceremony of the Florida Indians. From a print first published by Teodore de Brys in a "*Brevis narratis eorum quae in Florida Americae.*" Frankfort. 1591.

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JOURNAL OF

THE NEW ENGLAND BOTANICAL CLUB

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# STUDIES OF EARLY SPECIMENS AND REPORTS OF ILEX VOMITORIA

A. H. G. Alston[1] and Richard Evans Schultes[2]

A recent paper (Schultes in Bot. Mus. Leafl. Harvard Univ. 14 (1950) 97–105) has discussed the correct name of the yaupon, pointing out the reasons why *Ilex vomitoria* is the valid binomial for the species of holly which was the source of the famous "black drink," the ceremonial emetic used by the Indians of the southeastern part of the United States until about the beginning of the nineteenth century. In this article, reference was made to several pre-Linnaean names and citations, but it was not found necessary to enter into a general consideration of the early collections in order to review the taxonomic and nomenclatorial history of the plant since 1753.

The notes and observations which we present in the following pages outline the results of our study of certain classical and early collections of *Ilex vomitoria*, upon which were based authentic and often-quoted reports of the use of the plant amongst the aborigines. It is hoped that these notes may contribute to our understanding of the ethnobotanical history of this caffeine-bearing holly as well as afford further clarification of certain technical points in the early nomenclatorial and taxonomic studies of the plant.

We have been fortunate in finding a wealth of pre-Linnaean material preserved in the British Museum (Natural History) to

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the officers of which institution we are grateful for permission to examine the collections in question.

The earliest "description of the source of the emetic and stimulant drink of the Indians of Florida can be found in the account of the purification ceremony written down by Nuñez Cabeça de Vaca (Relación y comentarios . . .)" and published in 1542. A facsimile of the page bearing this earliest report was recently published (Schultes: loc. cit. t. 24). The drink, it was stated, was prepared from the leaves of trees resembling the live-oak ("las hojas de los árboles como de enzina . . ."). It should be noted that no common or native name for the plant was reported. No specimens are known to have been collected by this early expedition, even though numerous references were made to the plants and animals of the new lands.

The earliest use of the native name *cassine* in reference to the plant appears to be in the report of Narváez, who, in 1536, met with the drink amongst the Indians along the coast of Texas. In writing of the drink and of its uses, Narváez states (Hakluyt: "Principal Navigations Voyages Traffiques and Discoveries of the English Nation" 8 (1904) 454):

> "Afterwards he [the tribal leader] commandeth Cassine to be brewed, which is a drinke made of the leaves of a certaine tree. They drinke this cassine very hotte; he drinketh first, then causeth to be given thereof to all of them one after another in the same boule . . .
> Moreover, this drinke hath such a vertue, that as soone as they have drunke it, they become all in a sweate, which sweate being past, it taketh away hunger and thirst for four and twenty houres after."

Although Narváez gave no description of the source of the drink beyond stating that it was made from the "leaves of a certaine tree," his account is noteworthy because it is apparently the earliest use of the native name in connection with the plant, and the often-quoted report of the great hunger-and thirst-allaying properties was here set forth for the first time.

De Laudonnière, who led a Huguenot expedition to Florida in 1564, found the same ceremonial emetic in use amongst the Indians of the St. Johns River. His chronicler, Le Moyne, wrote ("Indorum Floridam provinciam inhabitantium eicones . . ." (1591) t. 29) that the drink, which was referred to as *cassine*, was made "from the leaves from a certain root." He gives no further description, nor were specimens gathered and

preserved for posterity. It is to Le Moyne, however, that we are indebted for a charming drawing of the ceremonial quaffing of the black drink during an Indian council (plate 1181).

From this extremely meagre knowledge of the source of a beverage for which such astounding properties were claimed and around the use of which such curious ceremonies had grown up, there was little advance for nearly two centuries. Even Bauhin, when he published his "Pinax" ((1623) 170), had no specimen at hand and was unable to describe or name the plant. He merely stated in this book: "Casina herba e cujus succo potionem coficiunt in Florida, quam bibunt in locum periculosum se conferunt, quo famen e sitim per horas 24 tollunt; para 2, Amer. navig. 4." This was repeated by Bauhin and Cherler in 1651 in their "Historia plantarum universalis" (3 (1651) 631), but still no description was offered. A. P. de Candolle's index of the Bauhin Herbarium at Basle (Bull. Herb. Boissier, ser. 2, 4 (1904) 752) listed only *Ilex Aquifolium*, so it is probable that Bauhin had never seen the plant and that his entire report was based on Narváez's account.

The earliest illustration of *Ilex vomitoria* which we have discovered is that published by Leonard Plukenet in 1705. A description of the plant in question was offered by Plukenet in 1700: "*Cassine vera Floridanorum Arbuscula baccifera Alaterni ferme facie, foliis alternatim sitis, tetrapyrene*" (Almagesti Botanici Mantissa (1700) 40). This description was followed by an illustration five years later ("Amaltheum Botanicum" 4 (1705) t. 376, f. 2). We have examined the Plukenet collection preserved in the Sloane Herbarium at the British Museum (Natural History) and find two specimens of *Ilex vomitoria;* one in Herb. Sloane No. 93 (p. 87); the other in Herb. Sloane No. 87 (p. 85). The latter specimen is a small fragment; the former is a good branching sprig from which, it is at once obvious, the Plukenet illustration was made. The illustration is an exact copy, published in reverse, of the sprig. Furthermore, this specimen is labelled, in Plukenet's own writing, with a statement that it represented "T.376, f.2", so this may be considered to be his personal testimony as to the source of the drawing.

In Plukenet's own copy of "Almagestum Botanicum" (1691), preserved in the library of the British Museum, there is a margi-

nal insert, in Plukenet's hand, on page 90 (between *Castanea sativa* and *Catsjan-Panel*) of the entire discussion and description of Cassine vera *Floridana* . . . which was later incorporated in the 1700 edition of "Almagesti Botanici . . ." Therefore, the earliest real botanical description based upon a specimen to which we may refer to-day was published in 1700, the first illustration, based upon an herbarium specimen, dated from 1705[3].

It is of great interest to note here that in the "Amaltheum Botanicum," in which volume the illustration of *Cassine vera Floridana* was published, there is no reference whatsoever to the plant in the text and that in the text reference to "Cassine vera Floridana" (or *Ilex vomitoria*) in the "Almagesti Botanici Mantissa," no reference whatsoever is made to the use of the plant in preparing a drink. There is, however, in the text of this volume a note which states that "Cassine altera *Floridana*, folio Alaterni *Hysicanensis* aemulo . . ." was used to make a drink like tea and which appears nearly equal in its powers ("e foliis hujus arboris potum Theae similem, & viribus fere parem, conficere dicuntur"). For this plant, Plukenet refers to t. 377, f. 4. The figure is an exact drawing of a specimen mounted on page 87 of the Sloane Herbarium Book No. 93, directly opposite the species of *Ilex vomitoria* and is referable to *I. Cassine* L., the dahoon holly. This is of the utmost significance, inasmuch as it is the first reliable botanical evidence that *Ilex Cassine* L., a species very distinct from *I. vomitoria* (one synonym of which is *I. Cassine* Walt., as discussed in Schultes loc. cit. 98), was used in making a tea-beverage. It must be borne in mind, however, that Plukenet did not state that this was the source of the *ceremonial emetic* which the Indians, from remote times, had employed in their councils.

There remains to discuss a curious occurrence in Plukenet's Almagesti Botanici when he refers to [*Ilex vomitoria* or] *Cassine vera Floridanorum*, with some doubt, a Cretan plant—"Abelicea s. Santalus adulterina." Plukenet's reference is to Bauhin's "Historia plantarium universalis" (1650) 490, which, in turn, was taken from Clusius' "Rariorum plantarum historia" (1601)

[3] These dates were given as 1691 and 1692, respectively, in Schultes: Bot. Mus. Leafl. Harvard Univ. 14 (1950) 99.

cccij. This plant, now called *Zelkova cretica* Spach, belongs to the *Urticaceae* and has, of course, nothing to do with *Ilex vomitoria*. He likewise reported as being the same as his "Cassine vera Floridanorum" the "Pseudosantalus Cretica abolicea dicta" on the basis of a drawing in Parkinson's "Theatrum Botanicum" cap. xlviii (1640); this plant likewise is referable to *Zelkova cretica*.

Petiver, an apothecary who lived from 1658 to 1718, amassed in London extremely interesting collections of plants, several sets of which are preserved in the Sloane Herbarium at the British Museum. An examination of these sets has revealed several points of interest. In the set included in the Sloane Herbarium Book No. 178 F. 10, there is a specimen numbered 19 and labelled "the true *Cassine* or *Carolina* Tea." Although Petiver's notes state that he believes it to be the same as the "yaupon" which, with its use by the Indians, Lawson described in his Natural History of Carolina (1718) 90, the specimen is definitely not *Ilex vomitoria*.

The name Carolina tea may, at that time, equally well have been applied to the aromatic *Symplocos tinctoria* (L.) L'Her., as shown by the specimen corresponding to Number 485 "*Thea* Caroliniana *Lauro Cerasi* fol." (Petiver: Mus. Petiver (1695) 42). The original label of the collector (Mr. Robert Rutherford, Surgeon) states: "Lawrell or Bayes bear a yellow flower in March and smell exceeding sweet." To this, Petiver has added, in his own handwriting, "Thea Caroliniana, MP485."

The specimen (Number 19) which Petiver has called "true Cassine" is a species of *Viburnum*. The leaves might be said superficially to resemble those of *Ilex vomitoria*, but that it cannot be an *Ilex* is attested by the regularly opposite placement of the leaves. There is, however, one separated leaf which is very definitely referable to *Ilex vomitoria* and which is mounted on the page next and very close to the sprig of *Viburnum*, so that there can be very little doubt that some confusion has occurred.

The specimen mounted next to this so-called "true Cassine"—Number 20—is likewise a *Viburnum* and can be referred rather definitely to *V. cassinoides*. This Petiver has called "Bitter Cassine or Cassio-berry Bush. Cassine Caroliniana, Arbuti folio," and he has further written that "this differs from the last

[i. e. Number 19] in having much larger and deeper notcht leaves, growing opposite." This very definite statement would lead us to believe that specimen Number 19 did *not* have opposite leaves, in which case we are, we believe, justified in assuming that the sprig of *Viburnum* with opposite leaves was inserted in Number 19 wrongly. Coupling this reasoning with the presence in one of the several Petiver sets at the British Museum of one leaf which is unquestionably of *Ilex vomitoria* under Number 19, we are encouraged to believe that an error has been committed.

In both the Petiver and Plukenet collections in the Sloane Herbarium, specimens of *Viburnum* have been mounted in close proximity to specimens of *Ilex vomitoria*. Sometimes they have been annotated as "another kind of Cassine" and, as we have seen, in several Petiver collections, even a twig of a *Viburnum* has been substituted, through error, in the place for *Ilex vomitoria*. This combination of circumstances might easily lead us to one of several conclusions: (1) the herbalists were trying to indicate merely a similarity between the *Viburnum* and the *Ilex* which, in the field, could attract attention or be the source of erroneous reports; or (2) they might have been suggesting (although they never state so) that a species of *Viburnum* was used together with the *Ilex vomitoria* or in its place.

In connection with the possible use of a *Viburnum* in preparing the black drink, it may be relevant to refer to a statement by Rafinesque (Med. Fl. 1, p. 9), who wrote that the weak infusion of the leaves of the "true casseena" are

> ". . . useful in stomach fevers, diabetes, small-pox, etc. as a mild emetic, but the Indians *black drink* is a strong concoction of them, and a violent, though harmless, vomitive. In North Carolina, the inhabitants of the sea side swamps, having no good water to drink, purify it by boiling it with a little casseena (perhaps *Viburnum cassinoides*) and use it constantly warm, as the Chinese do their daily tea. *I. Dahoon* and *I. Cassine* are used as substitutes for the casseena, and many other shrubs appear to be used indiscriminately for making the black drink: for example, the *Cassine ramulosa*[4] of the *Flora of Louisiana*. The use made of the leaves in Carolina or Florida by the native Indians has given rise to the opinion that this species was the Paraguay tea mentioned in Martyn's *Miller*, on the authority of M. Frazier; but the species which produces that article is the *I. paraguariensis* Lam. *I. vomitoria* is not very common in British collections. . ."

[4] A mere synonym of *Ilex vomitoria*.

This passage would, at first reading, give one the impression that perhaps many plants entered into the preparation of the black drink. Closer study, however, reveals a deep confusion in Rafinesque's mind. First, he says that casseena is perhaps *Viburnum cassinoides;* whether this is based on actual observation in the field or upon the suggestiveness of the specific epithet is not clear. Then, secondly, he states that *Ilex Cassine* L. (*I. Dahoon* Walt.) and *I. vomitoria* (*I. Cassine* Walt.) are used as substitutes for the casseena. Furthermore, thirdly, he speaks of "many other shrubs" which are used indiscriminately, and, as an example, he cites a *synonym* of *Ilex vomitoria!* In view of this uncertainty and of the general confusion characteristic of much of Rafinesque's work, we believe that this report of the use of numerous species in the manufacture of the black drink cannot be taken too seriously. We have considered it in detail here inasmuch as apparently most of the present reports which attribute the source of the cassine tea to several or more plants stem directly from Rafinesque's passage.

In none of the old collections and reports which we have examined is there reliable and directly stated evidence that any plant other than *Ilex vomitoria* was the widely employed source of the black drink. Not even the closely allied *Ilex Cassine* L. or dahoon can be pointed to as a possible source. As has been shown (Schultes, loc. cit.), endless confusion and uncertainty has resulted from the unfortunate application of the specific epithet *Cassine* by Linnaeus to a plant which is not the cassine but the dahoon and from the application of the same specific epithet shortly thereafter to the true cassine. Most chemical analyses which have been made are of extremely limited value since we cannot be certain whether the name "Ilex Cassine," which the chemists use to identify their material, refers to the cassine or to the dahoon. The only chemical studies of apparently accurately-determined material seem to be those of Power and Chestnut (in Journ. Amer. Chem. Soc. 41 (1919) 1307), who were cognizant of the nomenclatoral confusion surrounding the binomial "*Ilex Cassine*" and who definitely state (l. c. 1308) that "the *Ilex Cassine* of Walter (but not of Linné) is the *Ilex vomitoria* Aiton, and, as we have shown, it is only the species to which the latter name is now assigned which contains caffeine."

# A POPULATION STUDY OF THE VARIATION IN THE INFLORESCENCE OF SPIRAEA TOMENTOSA

Peter J. Salamun

## Introduction

In the Atlantic States and on the Coastal Plain the "common form" of *Spiraea tomentosa* L. has been described by Fernald (1912) as having a densely-flowered panicle, with the branches mostly compound, and the follicles permanently lanate. The inland phase, var. *rosea* (Raf.) Fern., has a less crowded panicle, with simple branches, and the follicles covered with tomentum which is promptly deciduous. An investigation of these characters in local population samples (Woodson, 1947) or mass collections (Anderson, 1941) and herbarium specimens corroborates the presence of two varieties. Some additional information has been obtained concerning the nature of this variation and the distribution of the two varieties.

## Morphological Characters

A preliminary examination of the material assembled indicated that some of the characters used to distinguish var. *tomentosa* and var. *rosea* are of doubtful taxonomic value. In both varities the branches are simple toward the tip, but usually possess smaller branches toward the base. Whether the follicles are lanate or tomentose also does not appear to be diagnostic, and no objective method has been devised to distinguish between these two kinds of pubescence. Similarly the deciduous nature of the tomentum cannot be readily compared. In no individual plants was the tomentum entirely lacking; some persisted even on the inflorescences of the previous year. It seems that the amount of tomentum may be correlated with the age of the follicles, but no distinct tendency could be associated with either variety.

The flowers of both varieties are predominantly rose-colored, but individuals with white flowers occasionally are found. The latter condition has been described as forma *albiflora* by Macbride (1915). It may be of interest to mention that the only

white-flowered individuals observed were herbarium specimens collected within the range of var. *tomentosa*.

The present study agrees with Professor Fernald's statement that the leaves of both var. *tomentosa* and var. *rosea* vary in outline from lanceolate to ovate-oblong, and the color of the tomentum of the lower surface ranges from white to rufous. Furthermore, the outline of the inflorescence varies from ovoid to narrowly pyramidal, with the lower branches slightly spreading to strongly ascending.

The character based on the crowding or density of the flowers or fruits on the branches of the panicle appears to be paramount, for a distinction between the two varietal entities can be made in a majority of instances by visual observation. When a more objective method is used, that of counting the number of flowers or fruits along a unit length of the inflorescence, var. *rosea* again stands out as different from var. *tomentosa*. The variation of this character is the basis for this study.

## Materials and Methods

Population samples, each consisting of an inflorescence bearing either mature flowers or fruits from a number of plants selected at random, were collected from 60 different localities. Individuals were picked with maximum regard to similarity of exposure on the plants, and at a sufficient distance apart to avoid clonal duplication. In most cases 25 or more individuals comprised a sample, but in a few localities a small number of plants were observed and correspondingly smaller collections were obtained.

The paucity of samples from the Middle Atlantic States, the northern Coastal Plain, and the southern and western periphery of the range necessitated some use of herbarium material. The use of this material together with population samples will be discussed later.

In each individual plant the number of flowers or fruits was determined for a unit length of one centimeter on the spire of the inflorescence, immediately above the first lateral branch. This position was selected because of its uniform exposure on the panicle, and the ease with which the flowers or fruits could be counted without destroying the structure. If the tip of the

inflorescence was damaged or destroyed, the count was made on a lower branch. A comparison of the density at the tip of the inflorescence with that of the lower branches in a large number of individuals disclosed a difference of only one flower or fruit per centimeter.

The variation in this character of crowding in local population samples is shown in Table 1, where the number of individuals are shown in the various density classes. For example, at Reedsburg, Wisconsin, the sample consisted of 63 individual plants. In 6 of these, 6 flowers or fruits were counted along one centimeter of a branch. Similarly, 13 individuals showed counts of 7, 24 had counts of 8, 14 had counts of 9, and 6 individual inflorescences were recorded as having 10 flowers or fruits per centimeter. From these data it is apparent that the range of the individuals from any one locality does not include the entire range of variability of the species-population, but varies within smaller limits about a central tendency. It may be also mentioned that the range of variation on a single plant is usually less than that of the local population. In some plants the inflorescences of the previous year persist enabling a comparison for a two year period. No significant difference in numbers was noted in this span of time.

Arithmetic means, representing the central tendencies for the samples, were computed and are also included in Table 1. Each of these values is plotted, in whole numbers, on Map 1. The plants having a tendency for densely-flowered panicles appear to predominate in the northeast portion of the range, whereas elsewhere those with less crowded inflorescences are more conspicuous.

From New Jersey to Missouri and southward only a few population samples were collected. Since the species appears to be quite rare in this region, further observations of this character were made from herbarium specimens.

A more complete coverage of the species range was made by combining herbarium specimens and population samples in the manner described by Woodson (1947). The range of *S. tomentosa* was divided into quadrats, each 100 miles square. All of the individuals collected within the limits of each quadrat were considered members of a population sample. The arithmetic means computed for these sample areas are plotted on Map 2. The results are strikingly similar to those shown in Map 1. Iso-

TABLE 1. The density of the inflorescence in population samples (mass collections) of *Spiraea tomentosa*.

| Locality | Number of flowers or fruits per centimeter | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | av. |
| WISCONSIN | | | | | | | | | | | | | | | | | | |
| Reedsburg | — | 6 | 13 | 24 | 14 | 6 | — | — | — | — | — | — | — | — | — | — | — | 8.0 |
| Hook Lake Bog | — | — | 5 | 7 | 6 | 5 | 2 | — | — | — | — | — | — | — | — | — | — | 8.7 |
| Millston (1) | 4 | 11 | 16 | 9 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | 6.9 |
| Millston (2) | — | — | 1 | 6 | 6 | 5 | 3 | — | — | — | — | — | — | — | — | — | — | 9.1 |
| Tomah | — | 2 | 6 | 7 | 3 | 2 | — | — | — | — | — | — | — | — | — | — | — | 7.9 |
| Merrillan | — | — | 1 | 11 | 25 | 20 | 18 | 1 | — | — | — | — | — | — | — | — | — | 9.6 |
| Oconto | — | 2 | 11 | 11 | 3 | 1 | — | — | — | — | — | — | — | — | — | — | — | 7.6 |
| Sarona | — | — | — | 3 | 9 | 6 | 2 | 2 | — | — | — | — | — | — | — | — | — | 9.6 |
| Packwaukee | — | — | 1 | 10 | 20 | 13 | 9 | 2 | 1 | — | — | — | — | — | — | — | — | 9.5 |
| Mill Bluff | — | — | 1 | 7 | 5 | 5 | 2 | — | 1 | — | — | — | — | — | — | — | — | 9.2 |
| Friendship | — | — | 1 | 9 | 11 | 13 | 5 | 1 | 1 | — | — | — | — | — | — | — | — | 9.5 |
| Adams | — | — | — | — | 4 | 6 | 1 | 2 | — | — | — | — | — | — | — | — | — | 10.1 |
| Shawano | — | 4 | 10 | 19 | 39 | 29 | 18 | 9 | — | — | — | — | — | — | — | — | — | 9.3 |
| Lake Mills | — | — | — | 1 | 3 | 2 | 1 | 2 | 1 | — | — | — | — | — | — | — | — | 10.3 |
| Stanley | — | — | — | 4 | 3 | 5 | 3 | 2 | 1 | 1 | — | — | — | — | — | — | — | 10.2 |
| Wis. Rapids | — | — | — | 7 | 21 | 16 | 13 | 10 | 6 | 1 | 1 | — | — | — | — | — | — | 10.3 |
| Ladysmith | — | 1 | — | 3 | 2 | 4 | 1 | 1 | — | — | — | — | — | — | — | — | — | 9.3 |
| Stevens Point | — | — | — | 2 | 4 | 10 | 9 | 6 | 3 | 3 | — | — | — | — | — | — | — | 10.9 |
| Marinette | — | 1 | 5 | 12 | 12 | 13 | 2 | 1 | — | — | — | — | — | — | — | — | — | 8.9 |
| Otsego | — | — | 3 | 5 | 1 | 1 | — | — | — | — | — | — | — | — | — | — | — | 8.0 |
| Monico | 1 | 3 | 4 | 6 | 5 | 3 | 1 | — | — | — | — | — | — | — | — | — | — | 9.0 |
| MINNESOTA | | | | | | | | | | | | | | | | | | |
| Duquette | — | 1 | 3 | 9 | 7 | 5 | 4 | 1 | — | — | — | — | — | — | — | — | — | 8.9 |
| Nickerson | — | — | — | 1 | 4 | 10 | 6 | 3 | 1 | — | — | — | — | — | — | — | — | 10.3 |
| INDIANA | | | | | | | | | | | | | | | | | | |
| Enos | — | — | 1 | 1 | 3 | 3 | 3 | 2 | — | — | — | — | — | — | — | — | — | 9.9 |
| Dune Park | — | — | 5 | 9 | 6 | 3 | 1 | — | — | — | — | — | — | — | — | — | — | 8.4 |
| East of Gary | — | — | — | 3 | 2 | 9 | 5 | 7 | 2 | 2 | 1 | — | — | — | — | — | — | 11.0 |

TABLE 1—(*Continued*)

| Locality | Number of flowers or fruits per centimeter | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | av. |
| MICHIGAN | | | | | | | | | | | | | | | | | | |
| Hibbard Lake | — | — | — | 5 | 1 | 3 | 2 | — | — | — | — | — | — | — | — | — | — | 9.2 |
| Marshall | — | — | 1 | 2 | 4 | 11 | 6 | 1 | — | — | — | — | — | — | — | — | — | 9.9 |
| OHIO | | | | | | | | | | | | | | | | | | |
| Akron | — | — | 2 | 5 | 5 | 6 | 9 | 4 | 1 | 1 | — | 1 | — | — | — | — | — | 10.3 |
| Salem | — | — | — | 2 | 2 | 6 | 3 | 8 | 1 | — | 2 | — | — | — | — | — | — | 11.1 |
| WEST VIRGINIA | | | | | | | | | | | | | | | | | | |
| Clintonville | — | — | — | 2 | 6 | 9 | 13 | 16 | 7 | — | — | — | — | — | — | — | — | 11.1 |
| PENNSYLVANIA | | | | | | | | | | | | | | | | | | |
| Kennett | — | — | 1 | 2 | 3 | 6 | 2 | 1 | — | 1 | — | — | — | — | — | — | — | 9.9 |
| Harmony | — | — | — | — | 3 | 5 | 11 | 10 | 9 | 3 | 2 | — | — | — | — | — | — | 11.8 |
| Ingomar | — | — | — | — | — | — | 1 | — | 4 | 3 | 4 | 4 | 1 | 1 | 2 | 1 | — | 15.3 |
| ONTARIO | | | | | | | | | | | | | | | | | | |
| North Bay | — | — | 1 | 1 | 6 | 8 | 1 | 3 | — | — | — | — | — | — | — | — | — | 9.8 |
| Iron Bridge | — | — | — | 5 | 12 | 15 | 16 | 12 | 3 | 2 | — | — | — | — | — | — | — | 10.6 |
| Cumberland | — | — | 1 | 2 | 6 | 9 | 9 | 9 | 7 | 1 | — | — | — | — | — | — | — | 10.9 |
| Brockville | — | — | — | — | 1 | 8 | 11 | 10 | 9 | 4 | — | — | — | — | — | — | — | 11.7 |
| Huntsville | — | — | — | — | — | — | 8 | 11 | 9 | 7 | 1 | — | — | — | — | — | — | 12.5 |
| Hawksbury | — | — | — | 1 | 1 | 7 | 6 | 11 | 10 | 12 | 5 | 3 | — | — | — | — | — | 12.6 |
| Havelach | — | — | — | — | — | 1 | 1 | — | 1 | 2 | 2 | — | — | — | — | — | — | 13.1 |
| QUEBEC | | | | | | | | | | | | | | | | | | |
| Bai de Pontiac | — | — | — | 1 | 7 | 12 | 15 | 11 | 5 | 1 | — | — | — | — | — | — | — | 11.9 |
| Montmagny | — | — | — | — | 2 | 3 | 3 | 1 | 3 | 6 | 4 | 2 | — | 2 | — | — | — | 13.2 |
| St. Clotilde | — | — | — | — | 1 | 3 | 5 | 9 | 17 | 10 | 8 | 7 | 3 | 1 | — | — | — | 13.5 |
| Victoriaville | — | — | — | — | — | 1 | 4 | 4 | 5 | 6 | 4 | 3 | — | 1 | — | — | — | 13.5 |
| St. Jovite | — | — | — | — | — | 2 | 7 | 10 | 16 | 14 | 13 | 8 | 1 | 1 | — | — | — | 13.6 |
| Lancaster | — | — | — | — | 1 | — | — | 2 | 3 | 3 | 4 | 2 | 1 | — | — | — | — | 13.9 |
| Disraeli | — | — | — | — | — | — | 2 | 5 | 8 | 10 | 11 | 10 | 15 | 10 | 7 | 2 | — | 15.7 |
| Dalesville | — | — | — | — | — | — | — | — | 9 | 12 | 15 | 14 | 14 | 7 | 3 | 1 | — | 15.7 |

TABLE 1—*Concluded*

| Locality | Number of flowers or fruits per centimeter | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | av. |
| QUEBEC—(*Continued*) | | | | | | | | | | | | | | | | | | |
| Bon Conseil | — | — | — | — | — | — | — | 1 | 7 | 7 | 14 | 19 | 22 | 16 | 5 | 4 | 4 | 16.5 |
| Cap St. Ignace | — | — | — | — | — | — | — | — | 2 | 11 | 16 | 19 | 12 | 13 | 8 | 6 | 4 | 16.7 |
| MAINE | | | | | | | | | | | | | | | | | | |
| Norridewalk | — | — | — | — | 2 | 2 | 8 | 13 | 8 | 2 | 2 | — | — | — | — | — | — | 12.0 |
| Medomak | — | — | — | — | 1 | 3 | 4 | 8 | 3 | 4 | 2 | — | 1 | — | — | — | — | 12.3 |
| Boothbay Harbor | — | — | — | — | — | 9 | 19 | 29 | 48 | 24 | 23 | 9 | 2 | — | — | — | — | 13.1 |
| MASSACHUSETTS | | | | | | | | | | | | | | | | | | |
| Bedford | — | — | — | — | 2 | 8 | 11 | 16 | 11 | 8 | 4 | 1 | — | — | — | — | — | 12.2 |
| Lancaster | — | — | — | — | — | 1 | 1 | 2 | 3 | 6 | 4 | 2 | — | — | — | — | — | 13.7 |
| NEW YORK | | | | | | | | | | | | | | | | | | |
| Waterville | — | — | — | — | 1 | 8 | 7 | 17 | 10 | 10 | 15 | — | — | — | — | — | — | 12.3 |
| Malone | — | — | — | — | — | — | 2 | 11 | 13 | 12 | 9 | 1 | — | — | — | — | — | 13.4 |
| Port Jervis | — | — | — | — | — | — | — | — | — | 5 | 8 | 9 | 15 | 7 | 4 | 2 | — | 16.6 |
| VERMONT | | | | | | | | | | | | | | | | | | |
| West Dover | — | — | — | — | — | 1 | 4 | — | 2 | — | 3 | 4 | 2 | 1 | — | — | — | 14.2 |

Map. 1. Average number of flowers or fruits per centimeter in population samples of *S. tomentosa*. Lined regions represent the approximate limits of the species as plotted by Gille (1949). Not all Wisconsin localities could be included. Base map reproduction by permission of McKnight & McKnight Publishing Company.

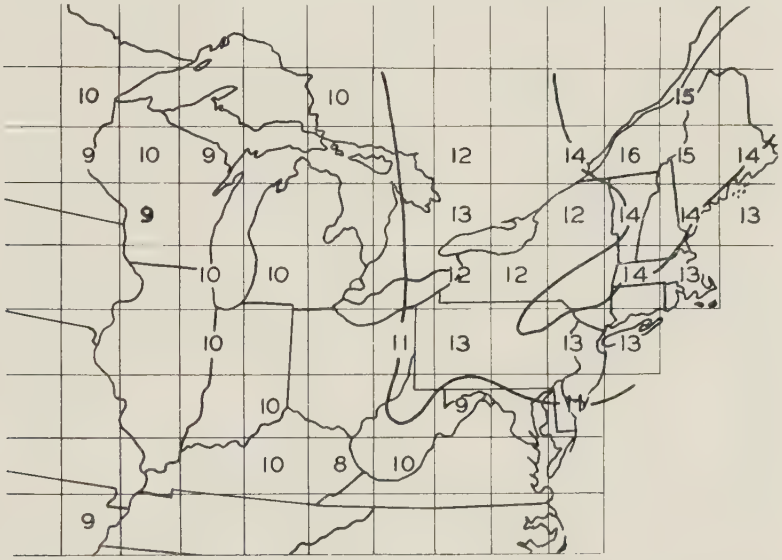
phenes of the values 11 and 14 are drawn to show the gradation of change in this character of crowding.

## Discussion

The pattern resulting from the two isophenes, in Map 2, is referred to as a cline. The line with the value 11 may be considered as the eastern boundary of the range of var. *rosea*, and the line with the value 14 as delimiting the western and southern boundary of extreme var. *tomentosa*. The intervening area may be considered as representing the intermediates. It is probable that this cline is the result of hybridization of individuals of the two varieites at the commissure of their ranges. Continuous back-crossing may have been responsible for the broad gradient indicated on the map. This flow of genes from one entity into another has been termed "introgressive hybridization" by

Anderson and Hubricht (1938), and shortened by other writers to "introgression."

Another interpretation of this cline may be that it represents a gradation of this character determined by environmental factors. Ecologists speak of this as an ecocline. According to




Map. 2. Average number of flowers or fruits per centimeter in quadrat samples of *S. tomentosa*. Isophenes represent values of 11 and 14. Base map reproduction by permission of McKnight & McKnight Publishing Company.

this idea, however, it is difficult to account for a concentration of densely-flowered inflorescences only in the northeast instead of also extending into the north and northwest portions of the range where similar environmental conditions occur.

Although data are sparse from the Coastal Plain region, there is some indication that sparsely-flowered individuals predominate. Herbarium specimens collected in southern New Jersey, Delaware, and eastern Maryland are mostly of the inland phase. Fernald also noted this, but considered these plants var. *tomentosa* on the basis of the persisting lanate follicles. It was earlier pointed out that this character is of doubtful importance, therefore it seems more appropriate to consider these plants as var. *rosea*. The southward extent of this plant on the Coastal Plain

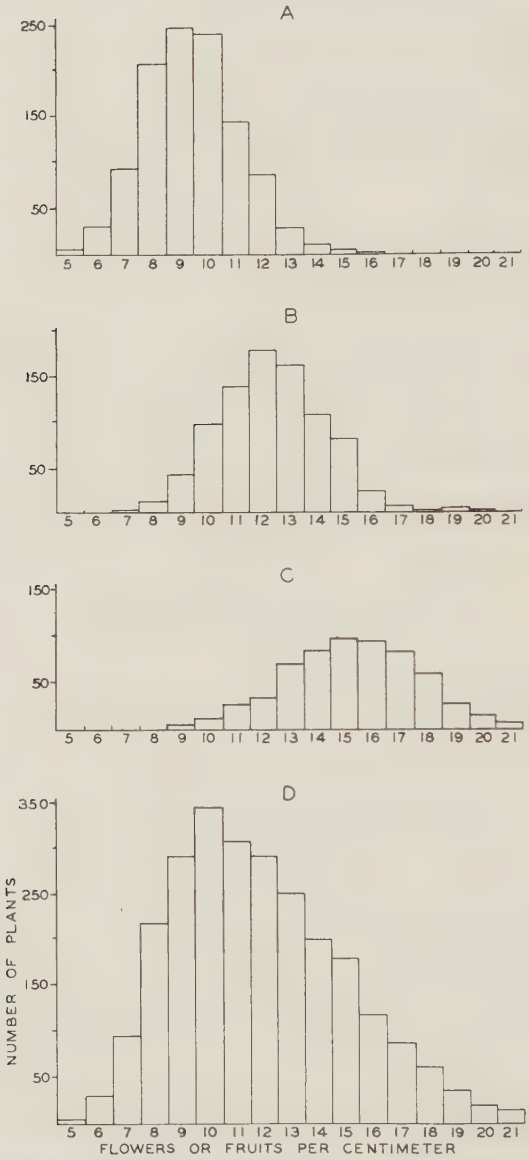



Fig. 1. Frequency distributions of individuals in population samples collected in the (A) west and south, (B) central, and (C) northeast portions of the range of the species (see Map 2). Graph (D) is a composite of (A), (B) and (C).

and the Piedmont Plateau could not be readily determined. The southeastern limit of the species, in Map 1, is based on a single specimen collected from South Carolina.[1]

In both Map 1 and Map 2 the arithmetic means along the New England coast are somewhat lower than in the interior. This suggests that some introgression of the sparsely-flowered variety may have occurred as far north as Maine and Nova Scotia.

The distribution of the individuals of population samples from the geographic area of each variety as well as of the species as a whole is shown in Fig. 1. In neither variety is the range of variation equal to that of the species. The overlapping ranges suggest a close relationship between the varieties. Individuals which may be considered var. *rosea*, in general, have 5 to 16 flowers or fruits per centimeter, while those of var. *tomentosa* generally have 9 to 21 per centimeter. This presents a problem in classifying, from the taxonomist's viewpoint, individuals within the 10 to 15 range. For example, a single specimen taken at random from a colony may have an inflorescence with a count of 10 flowers per centimeter, but the arithmetic mean for the entire colony might be 15. Is there any justification for calling this single plant var. *rosea?* Similarly it is sometimes difficult to classify population samples with intermediate averages. In general, population samples of var. *rosea* average 8 to 11 flowers or fruits per centimeter, and those of var. *tomentosa* average 14 to 17 per centimeter. Those with averages of 12 and 13 must be considered intermediates. In annotating them consideration must be given to their geographic distribution.

Although it is difficult to classify individual plants, and sometimes colonies, nevertheless, the general tendencies in the population samples show definite geographic affinities, and indicate the presence of two varieties. Since it seems necessary that some basis for distinguishing them be made, the following key will perhaps be of value.

a. Inflorescence densely-flowered, the pedicels hardly visible; in a colony the mature flowers or fruits average 12–17 per centimeter on the branches.

[1] Additional information from North Carolina has since been obtained through the courtesy of Dr. William B. Fox. Collections from Chowan, Tyrell, Bertie and Halifax counties average respectively, 9, 10, 9, and 9 flowers or fruits per centimeter.

b. Flowers rose-colored ..... *Spiraea tomentosa* L. var. *tomentosa*
bb. Flowers white ..... *S. tomentosa* L. var. *tomentosa* f. *albiflora* Macbr.
aa. Inflorescence less dense than above, the pedicels easily visible; in a colony the mature flowers or fruits average 8–11 per centimeter on the branches ..... *S. tomentosa* L. var. *rosea* (Raf.) Fern.

## Ecology and Distribution

*S. tomentosa* ranges from Nova Scotia to Minnesota, southward to Georgia and Arkansas. Field observations in the northern portion of this range, from Wisconsin to southwestern Quebec and Pennsylvania, indicate that the species prefers open places on acid soils, especially in pastures, and at the margin of bogs, sloughs and swales. A local study of the plant in the region of Granby, Quebec (Gille, 1949) disclosed similar habitat preferences. Its presence in these habitats implies that it is a successional rather than a climax species.

Although abundant in glaciated territory, the species probably migrated from some regions south of the terminal moraine. The unglaciated Allegheny Plateau, the Ozark Plateau, and the Driftless Area of southwestern Wisconsin and adjacent portions of Illinois, Iowa and Minnesota have been considered by botanists as plant refuges. More recently Wherry (1933) considered the northern portion of the Coastal Plain and the adjacent Piedmont Plateau as another possible refuge. From these areas it is probable that the species migrated in postglacial time.

It is not known whether the two varieties of *S. tomentosa* were distinct prior to migration from these refuges. The proximity of var. *tomentosa* to the two eastern refuges seems to indicate that its route of migration was northward and northeastward from them to its present location. The distribution of var. *rosea* indicates that it may have survived in all of these areas. However, the occurrence of the plant in the Driftless Area is confined chiefly to sandy areas formerly occupied by glacial lakes. This seems to indicate a postglacial migration of the plant into the region. The sparsity of plants in the Ozarkian area may imply either a recent migration into this region or an attenuation due to increasing aridity.

These possibilities of survival and migration may account for the present distribution of the species, but fail to explain the variation in abundance throughout the range. In the northeast the species is common in open pastures. Along the southern and western peripheries of its range it is quite rare. Extensive land utilization in the latter regions may have resulted in the destruction of many habitats. It is also probable that post-glacial climatic changes may have been earlier contributing factors to this reduction in abundance. The one or more xeric periods proposed by Sears (1935) and Transeau (1935) suggest that the plants in these regions may have been reduced to relic status prior to settlement.

## Summary

The study of the inflorescence of *Spiraea tomentosa*, in population samples and herbarium specimens, corroborates the presence of two varieties. The more crowded inflorescence is characteristic of var. *tomentosa*, which occurs in the northeastern part of the range of the species. Var. *rosea*, with the less crowded inflorescence, is the common phase in the interior and on the Coastal Plain. Although some individual plants of one region may seem to be characteristic of the other region, colonies within each region are quite distinct.

## Acknowledgements

The writer is indebted to Professor Norman C. Fassett for many population samples and for his friendly suggestions and criticisms of this work. A grant from the Wisconsin Alumni Research Foundation supported the writer as a research assistant and enabled him to collect many samples. Other samples were obtained through the kind cooperation of Dr. Wendell H. Camp, Dr. Olga Lakela, Dr. L. K. Henry, Dr. Herbert M. Clarke, Dr. Yves Desmarais, Dr. Forest W. Stearns, Mr. Joseph Barrell, Mr. David F. Grether, Mr. Robert Burton, Mr. Robert H. Brown, Mr. Robert Frey and Mrs. Margaret S. Bergseng. The writer also wishes to express his appreciation to the curators of the following herbaria for the loan of specimens: Gray Herbarium, Missouri Botanical Garden, Philadelphia Academy of Natural Sciences, University of Cincinnati, University of West Virginia and the University of Wisconsin.

Department of Biology, Wisconsin State College, Milwaukee.

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Frog Spit and Pond Scum[1]—Marine algae are generally known as seaweeds, but there is no comparable term for the freshwater forms which include many microscopic and thread-like plants which become apparent only in great numbers and which, because of their great differences in structure and physiology, are classified in several major divisions. These small forms of life are not only curious and often beautiful, but are of interest and importance because of their place at the base of aquatic food chains and because they sometimes play a detrimental role in potable water reservoirs.

The appearance of Prescott's "Algae of the Western Great Lakes Area" marks an important milestone in Midwestern phycology. Although excluding from the present volume the diatoms and the desmids (a group in which Prescott is an authority), this *magnum opus* is still nearly a thousand pages. It represents a significant achievement of the author and an important addition to the growing list of magnificent books published at cost as a service to science by the Cranbrook Institute of Science. Although limited to aquatic algae (excluding those of the Great Lakes) of Wisconsin and Michigan, and without attention to terrestrial forms, this manual will be widely used in the United States as well as by persons especially interested in phycology throughout the world. There are recent good books in English on the morphology, physiology, and taxonomy of algae, and there is an extensive although widely scattered journal literature, but no book of regional coverage known to the reviewer describes, keys-out, and illustrates, within the limits mentioned above, all of the known algal flora of a region.

The author has worked many years, both in Wisconsin and Michigan, carrying out the survey on which his book is based and accumulating his records of about 1300 species. A very large number of published records for algae have not been accepted by Prescott. Unless substantiated by pre-

[1] *Algae of the Western Great Lakes Area.* By G. W. Prescott. xiii + 946 pp. Aug., 1951. Bull. 31, Cranbrook Institute of Science, Bloomfield Hills, Michigan. $10.50.

served specimens or for other reasons known to be authentically reported, Prescott has preferred, and wisely so, to exclude reported species which have not come within his personal experience and observation. There remains, however, an impressively large number of species which come within his familiar purview.

The algae of the Western Great Lakes area are probably as well known as are those of any region of comparable size in the world. Prescott's useful compendium (together with his many original contributions), and the published books and papers of Gilbert M. Smith, Edgar N. Transeau, L. H. Tiffany, Francis Drouet, Charles M. Palmer, Clarence E. Taft, and many others, provide an extremely comprehensive and useful series of publications for the region, not only for phycologists, but also for hydrobiologists in general.

One of the outstanding features of Prescott's book is the final section which consists of 136 full-page plates, each with numerous line figures. Although considerable page space has been lost, the arrangement of the plate-legend on the lefthand page opposite each plate makes for ready comparison of the species involved. These legends give the Latin name, authority, and magnification of each of the species illustrated. Actual average dimensions of cells, colonies, etc., however, must be sought in the text. The illustrations are well drawn and the cuts are clean and well printed. In most cases related species occur on the same or succeeding plates, but there are some instances in which the illustrations of certain species are far removed from their congenors. To have avoided this would have required a considerable additional expenditure of time for the author and cost for the publisher, as the earlier plates were engraved several years before publication.

Among the distinctive features of Prescott's book is the bibliography which lists alphabetically about 700 authors and twice that many titles. The bibliography is apparently complete as to the literature in which each species and higher category was originally described. Pertinent manuals, floras, and other studies are also included. Publications relating to the region covered by the present manual are indicated by an asterisk. Important works concerning algal morphology, reproduction, and taxonomy are also indicated by a special symbol and referred to at appropriate places in the text. Thus it is possible for a student of the algae to turn easily from the manual to other sources of information to reinforce his knowledge of any group. In cases where there are several papers by the same author, they are listed chronologically in a continuous paragraph. The fact that the years of publication, as well as the special symbols referred to above, are not made to stand out by the use of bold-face type sometimes makes it tedious to find a particular reference, but this is a very minor criticism in the light of the large and useful bibliography which has, the reviewer believes, been carefully prepared by the author who has seen all the cited material and by the editor who has looked after standardization of style.

At the end of the systematic account, which covers about 500 pages, there is an analytical key to genera conveniently set in dichotomous form with consecutive numbering. This is a style that is economical of space and easy to follow. Thereafter is a 14-page glossary of technical and phycological terms and many others useful in the study of algae. Preceding the systematic account there are 13 plates with numerous figures illustrating morphological terms. This is a very useful feature of the book as the illustrations are grouped according to their relationships, rather than alphabetically. Thus there are groups of terms related to plane surfaces, regular solids, irregular

forms, terminal shapes and structures, surface characteristics, branching types, etc. The index contains mostly scientific names and refers to the plates as well as to the text references.

There are two non-taxonomic chapters of general interest. One treats geographical and geological features of algal distribution and the other the ecology of phytoplankton, especially the relations of these free-floating mostly microscopic algae to lake productivity.

To the reviewer, who is not a phycologist, Prescott's new book seems completely competent and reliable, and it will, I am sure, receive the praise of his professional colleagues who are specialists in algae. Foe the ecologist, general biologist, and amateur who is fortunate enough to own a microscope, Prescott's manual will be an important tool and the gateway to many pleasures with these ubiquitous but too little known organisms.—Stanley A. Cain, School of Natural Resources, University of Michigan, Ann Arbor.

*Volume 53, no. 635, including pages 249–272 and plates 1176–1180, was issued 21 November 1951.*

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## ERRATA

Page 20, line 21; for var. *neogaeas* read *neogaea.*
Page 41, line 35; for *on* read *one.*
Page 60, line 26; *for* mentoned *read* mentioned.
Page 73, line 5; for *Malaxia* read *Malaxis.*
Page 85, line 37; for *trifida* read *trifida*, var. *verna.*
Page 88, line 22; for *latifolium* read *hybridum.*
Page 112, line 31; for TENELLUM read TENELLUM.
Page 130, line 21; for CYPTOPTERIS read CYSTOPTERIS.
Page 160, line 6; for *Trigolochin* read *Triglochin.*
Page 187, line 43; *for* Charney *read* Charnay.
Opposite Page 192, legend; for XAMULATA read HAMULATA.
Page 208, line 23; for *includieg* read *including.*
Page 238, line 24; for *foliia* read *foliis.*
Page 247, line 19; for footnote reference see p. 248.
Page 248, line 39; for CORELL read CORRELL.
Page 248, line 42; *for* Scheinfurth *read* Schweinfurth.
Page 252, line 25; *for* vigorus *read* vigorous.
Opposite Page 260, line 18; for *macrophylla* read *macrocarpa.*

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